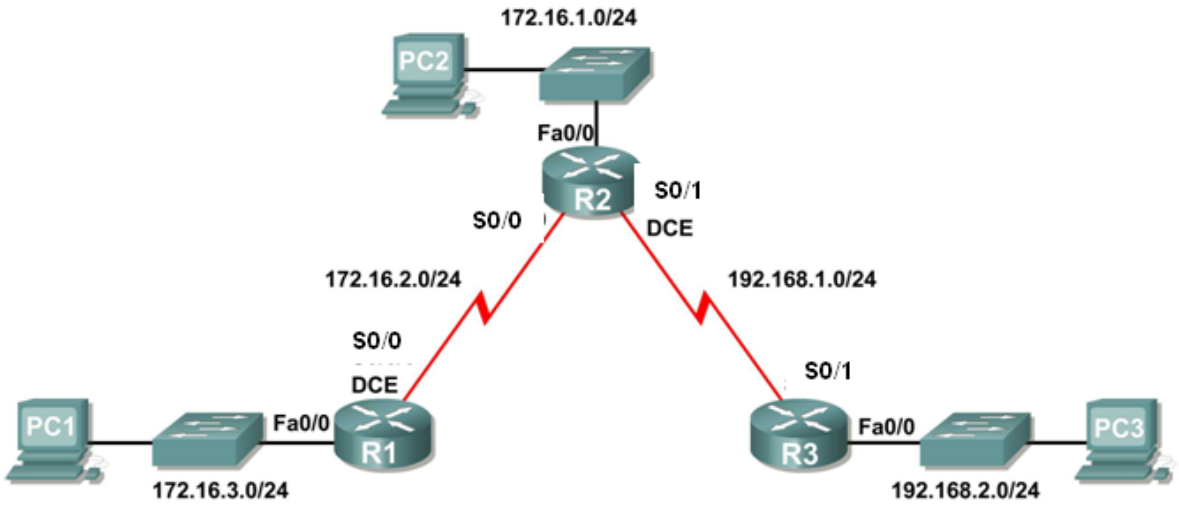
Lab 2.8.1: Basic Static Route Configuration (Cabrillo Version)

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	Fa0/0	172.16.3.1	255.255.255.0	N/A
	S0/0	172.16.2.1	255.255.255.0	N/A
R2	Fa0/0	172.16.1.1	255.255.255.0	N/A
	S0/0	172.16.2.2	255.255.255.0	N/A
	S0/1	192.168.1.2	255.255.255.0	N/A
R3	FA0/0	192.168.2.1	255.255.255.0	N/A
	S0/1	192.168.1.1	255.255.255.0	N/A
PC1	NIC	172.16.3.10	255.255.255.0	172.16.3.1
PC2	NIC	172.16.1.10	255.255.255.0	172.16.1.1
PC3	NIC	192.168.2.10	255.255.255.0	192.168.2.1

Learning Objectives

Upon completion of this lab, you will be able to:

- Cable a network according to the Topology Diagram.
- Erase the startup configuration and reload a router to the default state.
- Perform basic configuration tasks on a router.

- Interpret **debug ip routing** output.
- Configure and activate Serial and Ethernet interfaces.
- Test connectivity.
- Gather information to discover causes for lack of connectivity between devices.
- Configure a static route using an intermediate address.
- Configure a static route using an exit interface.
- Compare a static route with intermediate address to a static route with exit interface.
- Configure a default static route.
- Configure a summary static route.
- Document the network implementation.

Scenario

In this lab activity, you will create a network that is similar to the one shown in the Topology Diagram. Begin by cabling the network as shown in the Topology Diagram. You will then perform the initial router configurations required for connectivity. Use the IP addresses that are provided in the Addressing Table to apply an addressing scheme to the network devices. After completing the basic configuration, test connectivity between the devices on the network. First test the connections between directly connected devices, and then test connectivity between devices that are not directly connected. Static routes must be configured on the routers for end-to-end communication to take place between the network hosts. You will configure the static routes that are needed to allow communication between the hosts. View the routing table after each static route is added to observe how the routing table has changed.

Using WebCT answer the questions in this assignment.

Task 1: Cable, Erase, and Reload the Routers. (Networking Lab Only)

Step 1: Cable a network that is similar to the one in the Topology Diagram.

Step 2: Clear the configuration on each router.

If necessary, clear the configuration on each of the routers using the **erase startup-config** command and then **reload** the routers. Answer **no** if asked to save changes.

Task 2: Perform Basic Router Configuration.

Note: If you have difficulty with any of the commands in this task, see **Lab 1.5.1: Cabling a Network and Basic Router Configuration**.

Step 1: Use global configuration commands.

On the routers, enter global configuration mode and configure the basic global configuration commands including:

- **hostname**
- **no ip domain-lookup**
- **enable secret**

Step 2: Configure the console and virtual terminal line passwords on each of the routers.

- **password**
- **login**

Step 3: Add the `logging synchronous` command to the console and virtual terminal lines.

This command is very helpful in both lab and production environments and uses the following syntax:

```
Router(config-line)#logging synchronous
```

To synchronize unsolicited messages and debug output with solicited Cisco IOS software output and prompts for a specific console port line, auxiliary port line, or virtual terminal line, we can use the **`logging synchronous`** line configuration command. In other words, the **`logging synchronous`** command prevents IOS messages delivered to the console or Telnet lines from interrupting your keyboard input.

For example, you may have already experienced something similar to the following example:

Note: *Do not* configure R1 interfaces yet.

```
R1(config)#interface fastethernet 0/0
R1(config-if)#ip address 172.16.3.1 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#descri
*Mar  1 01:16:08.212: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed
state to up
*Mar  1 01:16:09.214: %LINEPROTO-5-UPDOWN: Line protocol on Interface
FastEthernet0/0, changed state to upption
R1(config-if)#
```

The IOS sends unsolicited messages to the console when you activate an interface with the **`no shutdown`** command. However, the next command you enter (in this case, **`description`**) is interrupted by these messages. The **`logging synchronous`** command solves this problem by copying the command entered up to that point down to the next router prompt.

```
R1(config)#interface fastethernet 0/0
R1(config-if)#ip address 172.16.3.1 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#description
*Mar  1 01:28:04.242: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed
state to up
*Mar  1 01:28:05.243: %LINEPROTO-5-UPDOWN: Line protocol on Interface
FastEthernet0/0, changed state to up
R1(config-if)#description  <-- Keyboard input copied after message
```

R1 is shown here as an example. Add **`logging synchronous`** to the console and virtual terminal lines on all routers.

```
R1(config)#line console 0
R1(config-line)#logging synchronous
R1(config-line)#line vty 0 4
R1(config-line)#logging synchronous
```

Step 4: Add the `exec-timeout` command to the console and virtual terminal lines.

To set the interval that the EXEC command interpreter waits until user input is detected, we can use the **`exec-timeout`** line configuration command. If no input is detected during the interval, the EXEC facility resumes the current connection. If no connections exist, the EXEC facility returns the terminal to the idle state and disconnects the incoming session. This command allows you to control the amount of time a console or virtual terminal line can be idle before the session is terminated. The syntax follows:

```
Router(config-line)#exec-timeout minutes [seconds]
```


Syntax description:

minutes—Integer that specifies the number of minutes.

seconds—(Optional) Additional time intervals in seconds.

In a lab environment, you can specify “no timeout” by entering the **exec-timeout 0 0** command. This command is very helpful because the default timeout for lines is 10 minutes. However, for security purposes, you would not normally set lines to “no timeout” in a production environment.

R1 is shown here as an example.

Add **exec-timeout 0 0** to console and virtual terminal lines on all routers.

```
R1(config)#line console 0
R1(config-line)#exec-timeout 0 0
R1(config-line)#line vty 0 4
R1(config-line)#exec-timeout 0 0
```

Task 3: Interpreting Debug Output.

Note: If you already configured IP addressing on R1, please remove all `interface` commands now before proceeding. R1, R2 and R3 should be configured through the end of Task 2 without any interface configurations.

Step 1: On R1 from privileged EXEC mode, enter the debug ip routing command.

```
R1#debug ip routing
IP routing debugging is on
```

The **debug ip routing** command shows when routes are added, modified, and deleted from the routing table. For example, every time you successfully configure and activate an interface, Cisco IOS adds a route to the routing table. We can verify this by observing output from the **debug ip routing** command.

Step 2: Enter interface configuration mode for R1’s LAN interface.

```
R1#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#interface fastethernet 0/0
```

Configure the IP address as specified in the Topology Diagram.

```
R1(config-if)#ip address 172.16.3.1 255.255.255.0
is_up: 0 state: 6 sub state: 1 line: 1 has_route: False
```

As soon as you press the **Enter** key, Cisco IOS debug output informs you that there is now a route, but its state is False. In other words, the route has not yet been added to the routing table.

Step 3: Activate the interface to install the route in the routing table.

```
R1(config-if)#no shutdown
```

After you enter the command above, you should see debug output. Your output may be slightly different from the example below.

```
is_up: 1 state: 4 sub state: 1 line: 1 has_route: False
RT: add 172.16.3.0/24 via 0.0.0.0, connected metric [0/0]
```



```
RT: NET-RED 172.16.3.0/24
RT: NET-RED queued, Queue size 1
RT: interface FastEthernet0/0 added to routing table
%LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
is_up: 1 state: 4 sub state: 1 line: 1 has_route: True
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, chan
ged state to up
is_up: 1 state: 4 sub state: 1 line: 1 has_route: True
is_up: 1 state: 4 sub state: 1 line: 1 has_route: True
```

The new network you configured on the LAN interface is now added to the routing table, as shown in the highlighted output.

If you do not see the route added to the routing table, the interface did not come up. Use the following systematic process to troubleshoot your connection:

1. Check your physical connections to the LAN interface.
   Is the correct interface attached?
   Your router may have more than one LAN interface. Did you connect the correct LAN interface?
   LAN will not come up unless it detects a carrier detect signal at the Physical layer from another device. Is the interface connected to another device such as a hub, switch, or PC?
2. Check link lights. Are all link lights blinking?
3. Check the cabling. Are the correct cables connected to the devices?
4. Has the interface been activated or enabled?

If you can answer **yes** to all the proceeding questions, the interface should come up.

Step 4: Enter the command to verify that the new route is now in the routing table.

Your output should look similar to the following output. There should now be one route in the table for R1.

```
R1#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 1 subnets
C       172.16.3.0 is directly connected, FastEthernet0/0
```

Step 5: Enter interface configuration mode for R1's WAN interface connected to R2.

```
R1#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#interface Serial 0/0
```

Configure the IP address as specified in the Topology Diagram.

```
R1(config-if)#ip address 172.16.2.1 255.255.255.0
is_up: 0 state: 0 sub state: 1 line: 0 has_route: False
```


As soon as you press the **Enter** key, Cisco IOS debug output informs you that there is now a route, but its state is `False`. Because R1 is the DCE side of our lab environment, we must specify how fast the bits will be clocked between R1 and R2.

Step 6: Enter the `clock rate` command on R1.

You can specify any valid clocking speed. Use the **?** to find the valid rates. Here, we used 64000 bps.

```
R1(config-if)#clock rate 64000
is_up: 0 state: 0 sub state: 1 line: 0 has_route: False
```

Some IOS versions display the output shown above every 30 seconds.

Step 7: Activate the interface to ensure that the interface is fully configured.

```
R1(config-if)#no shutdown
```

After you enter the correct command, you should see debug output similar to the following example:`is_up: 0 state: 0 sub state: 1 line: 0 has_route: False`

```
%LINK-3-UPDOWN: Interface Serial0/0, changed state to down
```

Unlike configuring the LAN interface, fully configuring the WAN interface does not always guarantee that the route will be entered in the routing table, even if your cable connections are correct. The other side of the WAN link must also be configured.

Step 8: If possible, establish a separate terminal session by consoling into R2 from another workstation. Doing this allows you to observe the debug output on R1 when you make changes on R2. You can also turn on **`debug ip routing`** on R2.

```
R2#debug ip routing
IP routing debugging is on
```

Enter interface configuration mode for R2's WAN interface connected to R1.

```
R2#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#interface serial 0/0
```

Configure the IP address as specified in the Topology Diagram.

```
R2(config-if)#ip address 172.16.2.2 255.255.255.0
is_up: 0 state: 6 sub state: 1 line: 0
```

Step 9: Activate the interface to ensure that the interface is fully configured.

```
R2(config-if)#no shutdown
```

After you enter the correct command, you should see debug output similar to the following example:

```
is_up: 0 state: 4 sub state: 1 line: 0
%LINK-3-UPDOWN: Interface Serial0/0, changed state to up
is_up: 1 state: 4 sub state: 1 line: 0
RT: add 172.16.2.0/24 via 0.0.0.0, connected metric [0/0]
RT: interface Serial0/0 added to routing table
is_up: 1 state: 4 sub state: 1 line: 0
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
is_up: 1 state: 4 sub state: 1 line: 0
```

The new network that you configured on the LAN interface is now added to the routing table, as shown in the highlighted output.

If you do not see the route added to the routing table, the interface did not come up. Use the following systematic process to troubleshoot your connection:

1. Check your physical connections between the two WAN interfaces for R1 and R2.
   Is the correct interface attached?
   Your router has more than one WAN interface. Did you connect the correct WAN interface?
   An interface will not come up unless it detects a link beat at the Physical layer from another device. Is the interface connected to the other router's interface?
2. Check link lights. Are all link lights blinking?
3. Check the cabling. R1 must have the DCE side of the cable attached and R2 must have the DTE side of the cable attached. Are the correct cables connected to the routers?
4. Has the interface been activated or enabled?

If you can answer **yes** to all the proceeding questions, the interface should come up.

Step 10: Verify that the new route is now in the routing table for R1 and R2.

Your output should look similar to the following output. There should now be two routes in the routing table for R1 and one route in the table for R2. What command did you use?

```
R1#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.2.0 is directly connected, Serial0/0
C       172.16.3.0 is directly connected, FastEthernet0/0


R2#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 1 subnets
C       172.16.2.0 is directly connected, Serial0/0
```

Step 11: Turn off debugging on both routers using either no debug ip routing or simply, undebug all.

```
R1(config-if)#end
R1#no debug ip routing
IP routing debugging is off
```


Task 4: Finish Configuring Router Interfaces

Step 1: Configure Remaining R2 Interfaces

Finish configuring the remaining interfaces on R2 according to the Topology Diagram and Addressing Table.

Step 2: Configure R3 Interfaces

Console into R3 and configure the necessary interfaces according to the Topology Diagram and Addressing Table.

Task 5: Configure IP Addressing on the Host PCs. (Networking Lab Only)

Step 1: Configure the host PC2.

Configure the host PC1 with an IP address of 172.16.3.10/24 and a default gateway of 172.16.3.1.

Step 2: Configure the host PC2.

Configure the host PC2 with an IP address of 172.16.1.10/24 and a default gateway of 172.16.1.1.

Step 3: Configure the host PC3.

Configure the host PC3 with an IP address of 192.168.2.10/24 and a default gateway of 192.168.2.1.

Task 6: Test and Verify the Configurations. (Networking Lab Only)

Step 1: Test connectivity.

Test connectivity by pinging from each host to the default gateway that has been configured for that host.

From the host PC1, you should be able to ping its default gateway.

From the host PC2, you should be able to ping its default gateway.

From the host PC3, you should be able to ping its default gateway.

If the answer is **no** for any of these questions, troubleshoot the configurations to find the error using the following systematic process:

1. Check the cabling.
   Are the PCs physically connected to the correct router?
   (Connection could be through a switch or directly)
   Are link lights blinking on all relevant ports?
2. Check the PC configurations. Do they match the Topology Diagram?
3. Check the router interfaces using the **`show ip interface brief`** command.
   Are all relevant interfaces **up** and **up**?

If your answer to all three steps is **yes**, you should be able to successfully ping the default gateway.

Step 2: Use the `ping` command to test connectivity between directly connected routers.

From the router R2, you should be able to ping R1 at 172.16.2.1.

From the router R2, you should be able to ping R3 at 192.168.1.1.

If the answer is **no** for any of these questions, troubleshoot the configurations to find the error using the following systematic process:

1. Check the cabling.
   Are the routers physically connected?
   Are link lights blinking on all relevant ports?
2. Check the router configurations.
   Do they match the Topology Diagram?
   Did you configure the **clock rate** command on the DCE side of the link?
3. Has the interface been activated or enabled?
4. Check the router interfaces using the **show ip interface brief** command.
   Are the interfaces **up** and **up**?

If your answer to all three steps is **yes**, you should be able to successfully ping from R2 to R1 and from R2 to R3.

Step 3: Use ping to check connectivity between devices that are not directly connected.

From the host PC3, you will not be able to ping the host PC1.

From the host PC3, you will not be able to ping the host PC2.

From the host PC2, you will not be able to ping the host PC1.

From the router R1, you will not be able to ping router R3.

6-1: Assuming these PCs are configured with proper IP addresses and default gateway address, the pings will all fail. Why?

a. Not all of the interfaces have been activated.
b. The routers need additional IP addresses configured on their interfaces.
c. At this point, routers only know about their own directly connected networks.

Task 7: Gather Information.

Step 1: Check status of interfaces.

Check the status of the interfaces on each router with the command **show ip interface brief**. The following output is for R2.

```
R2#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/0        172.16.1.1      YES manual up                    up
FastEthernet0/1        unassigned      YES unset  administratively down down
Serial0/0              172.16.2.2      YES manual up                    up
Serial0/1              192.168.1.2     YES manual up                    up
```

All of the relevant interfaces on each router activated (that is, in the **up** and **up** state).

7-1: How many interfaces are activated ("up" and "up") on each of the routers R1 and R3?

a. 1
b. 2
c. 3
d. 4

7-2: Why are there three activated ("up" and "up") interfaces on R2?

a. R2 has two WAN links and a LAN link

b. R2 has one WAN link and two LAN links

c. R2 has three WAN links

d. R2 has three LAN links

Step 2: View the routing table information for all three routers.

```
R1#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.2.0 is directly connected, Serial0/0
C       172.16.3.0 is directly connected, FastEthernet0/0
```

7-3: What networks are present in the Topology Diagram but not in the routing table for R1? (choose all that apply)

a. 172.16.1.0/24

b. 172.16.2.0/24

c. 172.16.3.0/24

d. 192.168.1.0/24

e. 192.168.2.0/24

```
R2#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
       U - per-user static route, o - ODR

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.1.0 is directly connected, FastEthernet0/0
C       172.16.2.0 is directly connected, Serial0/0
C    192.168.1.0/24 is directly connected, Serial0/1
```


7-4: What networks are present in the Topology Diagram but not in the routing table for R2? (choose all that apply)

a. 172.16.1.0/24

b. 172.16.2.0/24

c. 172.16.3.0/24

d. 192.168.1.0/24

e. 192.168.2.0/24

```
R3#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
       U - per-user static route, o - ODR

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, Serial0/1
C    192.168.2.0/24 is directly connected, FastEthernet0/0
```

7-5: What networks are present in the Topology Diagram but not in the routing table for R3? (choose all that apply)

a. 172.16.1.0/24

b. 172.16.2.0/24

c. 172.16.3.0/24

d. 192.168.1.0/24

e. 192.168.2.0/24

7-6: What needs to be configured on all routers for all networks to be in their routing tables?

a. static routes or a dynamic routing protocol

b. static routes, a dynamic routing protocol would not be a solution

c. a dynamic routing protocol, static routes would not be a solution

Task 8: Configure a Static Route Using a Next-Hop Address.

Step 1: To configure static routes with a next-hop specified, use the following syntax:

```
Router(config)# ip route network-address subnet-mask ip-address
```

- *network-address*:—Destination network address of the remote network to be added to the routing table.
- *subnet-mask*—Subnet mask of the remote network to be added to the routing table. The subnet mask can be modified to summarize a group of networks.
- *ip-address*—Commonly referred to as the next-hop router's IP address.

On the R3 router, configure a static route to the 172.16.1.0 network using the Serial 0/1 interface of R2 as the next-hop address.

```
R3(config)#ip route 172.16.1.0 255.255.255.0 192.168.1.2
R3(config)#
```

Step 2: View the routing table to verify the new static route entry.

Notice that the route is coded with an **S**, which means that the route is a **static** route.

```
R3#show ip route

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
       U - per-user static route, o - ODR

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 1 subnets
S       172.16.1.0 [1/0] via 192.168.1.2
C    192.168.1.0/24 is directly connected, Serial0/1
C    192.168.2.0/24 is directly connected, FastEthernet0/0
R3#
```

With this route entered in the routing table, any packet that matches the first 24 left-most bits of 172.16.1.0/24 will be forwarded to the next-hop router at 192.168.1.2.

8-1: Using the topology diagram, what interface will R3 use to forward packets to the 172.16.1.0/24 network?

a. Fa0/0

b. Serial 0/1

8-2 through 8-6: Assume that the following packets have arrived at R3 with the indicated destination addresses. Will R3 discard (drop) the packet or forward the packet? If R3 forwards the packet, with what interface will R3 send the packet, Fa0/0 or S0/1?

Question	Destination IP	Discard or Forward?	Interface
8-2	172.16.2.1		
8-3	172.16.1.10		
8-4	192.168.1.2		
8-5	172.16.3.10		
8-6	192.168.2.10		

Although R3 will forward packets to destinations for which there is a route, this does not mean that a packet will arrive safely at the final destination.

Step 3: Use `ping` to check connectivity between the host PC3 and the host PC2.

From the host PC3, it is still not possible to ping the host PC2.

These pings should fail. The pings will arrive at PC2 if you have configured and verified all devices through Task 6, “Gather Information.” PC2 will send a ping reply back to PC3. However, the ping reply will be discarded at R2 because the R2 does not have a return route to the 192.168.2.0 network in the routing table.

Step 4: On the R2 router, configure a static route to reach the 192.168.2.0 network.

What is the next-hop address to which R2 would send a packet destined for the 192.168.2.0/24 network?

```
R2(config)#ip route 192.168.2.0 255.255.255.0 192.168.1.1
R2(config)#
```

Step 5: View the routing table to verify the new static route entry.

Notice that the route is coded with an **S**, which means the route is a **static** route.

```
R2#show ip route

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
       U - per-user static route, o - ODR

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.1.0 is directly connected, FastEthernet0/0
C       172.16.2.0 is directly connected, Serial0/0
C    192.168.1.0/24 is directly connected, Serial0/1
S    192.168.2.0/24 [1/0] via 192.168.1.1
R2#
```

Step 6: Use ping to check connectivity between the host PC3 and the host PC2.

From the host PC3, you should be able to ping the host PC2. This ping should be successful.

Task 9: Configure a Static Route Using an Exit Interface.

To configure static routes with an exit interface specified, use the following syntax:

```
Router(config)# ip route network-address subnet-mask exit-interface
```

- *network-address*—Destination network address of the remote network to be added to the routing table.
- *subnet-mask*—Subnet mask of the remote network to be added to the routing table. The subnet mask can be modified to summarize a group of networks.
- *exit-interface*—Outgoing interface that would be used in forwarding packets to the destination network.

Step 1: On the R3 router, configure a static route.

On the R3 router, configure a static route to the 172.16.2.0 network using the Serial 0/0 interface of the R3 router as the exit interface.

```
R3(config)# ip route 172.16.2.0 255.255.255.0 Serial0/1
R3(config)#
```

Step 2: View the routing table to verify the new static route entry.

```
R3#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
```



```
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
       U - per-user static route, o - ODR

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 2 subnets
S       172.16.1.0 [1/0] via 192.168.1.2
S       172.16.2.0 is directly connected, Serial0/1
C    192.168.1.0/24 is directly connected, Serial0/1
C    192.168.2.0/24 is directly connected, FastEthernet0/0
R3#
```

Use the **show running-config** command to verify the static routes that are currently configured on R3.

```
R3#show running-config
Building configuration...

<output omitted>
!
hostname R3
!
interface FastEthernet0/0
ip address 192.168.2.1 255.255.255.0
!
interface Serial0/0
 no ip address
 shutdown
!
interface Serial0/1
 ip address 192.168.1.1 255.255.255.0
!
ip route 172.16.1.0 255.255.255.0 192.168.1.2
ip route 172.16.2.0 255.255.255.0 Serial0/1
!
end
```

Step 3: On the R2 router, configure a static route.

On the R2 router, configure a static route to the 172.16.3.0 network using the Serial 0/0 interface of the R2 router as the exit interface.

```
R2(config)# ip route 172.16.3.0 255.255.255.0 Serial0/0
R2(config)#
```

Step 4: View the routing table to verify the new static route entry.

```
R2#show ip route

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
       U - per-user static route, o - ODR

Gateway of last resort is not set
```



```
     172.16.0.0/24 is subnetted, 3 subnets
C       172.16.1.0 is directly connected, FastEthernet0/0
C       172.16.2.0 is directly connected, Serial0/0
S       172.16.3.0 is directly connected, Serial0/0
C    192.168.1.0/24 is directly connected, Serial0/1
S    192.168.2.0/24 [1/0] via 192.168.1.1
R2#
```

At this point, R2 has a complete routing table with valid routes to all five networks shown in the Topology Diagram.

Does this mean that R2 can receive ping replies from all destinations shown in the Topology Diagram? No. Although R2 can route to all networks in the Topology, this does not guarantee that other routers can route back to R2.

Step 5: Use `ping` to check connectivity between the host PC2 and PC1.

This ping should fail because the R1 router does not have a return route to the 172.16.1.0 network in the routing table.

Task 10: Configure a Default Static Route.

In the previous steps, you configured the router for specific destination routes. But could you do this for every route on the Internet? No. The router and you would be overwhelmed. To minimize the size of the routing tables, add a default static route. A router uses the default static route when there is not a better, more specific route to a destination.

Instead of filling the routing table of R1 with static routes, we could assume that R1 is a *stub router*. This means that R2 is the default gateway for R1. If R1 has packets to route that do not belong to any of R1 directly connected networks, R1 should send the packet to R2. However, we must explicitly configure R1 with a default route before it will send packets with unknown destinations to R2. Otherwise, R1 discards packets with unknown destinations.

To configure a default static route, use the following syntax:

```
Router(config)#ip route 0.0.0.0 0.0.0.0 { ip-address | interface }
```

Step 1: Configure the R1 router with a default route.

Configure the R1 router with a default route using the Serial 0/0 interface of R1 as the next-hop interface.

```
R1(config)#ip route 0.0.0.0 0.0.0.0 172.16.2.2
R1(config)#
```

Step 2: View the routing table to verify the new static route entry.

```
R1#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
       U - per-user static route, o - ODR

Gateway of last resort is 172.16.2.2 to network 0.0.0.0

     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.2.0 is directly connected, Serial0/0
C       172.16.3.0 is directly connected, FastEthernet0/0
S*   0.0.0.0/0 [1/0] via 172.16.2.2
R1#
```


Note that the R1 router now has a default route, the *gateway of last resort*, and will send all unknown traffic out Serial 0/0, which is connected to R2.

Step 3: Use `ping` to check connectivity between the host PC2 and PC1. (Can only be done in Networking Lab, not with NetLab.)

Host PC2 pings the host PC1. This ping should be successful this time because the R1 router can return the packet using the default route.

Host PC3 pings the host PC1. This ping should fail.

10-1: Why would a ping from PC3 to PC1 fail?

a. R1 does not have a route back to 192.168.2.0/24 network.

b. R2 does not have a route back to 192.168.2.0/24 network.

c. R3 does not have a route for 172.16.1.0/24 network.

d. R3 does not have a route for 172.16.2.0/24 network.

e. R3 does not have a route for 172.16.3.0/24 network.

Task 11: Configure a Summary Static Route.

We could configure another static route on R3 for the 172.16.3.0 network. However, we already have two static routes to 172.16.2.0/24 and 172.16.1.0/24. Because these networks are so close together, we can summarize them into one route. Again, doing this helps reduce the size of routing tables, which makes the route lookup process more efficient.

Looking at the three networks at the binary level, we can a common boundary at the 22nd bit from the left.

```
172.16.1.0      10101100.00010000.000000|01.00000000
172.16.2.0      10101100.00010000.000000|10.00000000
172.16.3.0      10101100.00010000.000000|11.00000000
```

The prefix portion will include 172.16.0.0, because this would be the prefix if we turned off all the bits to the right of the 22nd bit.

```
Prefix    172.16.0.0
```

To mask the first 22 left-most bits, we use a mask with 22 bits turned on from left to right:

```
Bit Mask 11111111.11111111.11111100.00000000
```

This mask, in dotted-decimal format, is...

```
Mask      255.255.252.0
```

Step 1: Configure the summary static route on the R3 router.

The network to be used in the summary route is 172.16.0.0/22.

```
R3(config)#ip route 172.16.0.0 255.255.252.0 192.168.1.2
```

Step 2: Verify that the summary route is installed in the routing table.

```
R3#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
```



```
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/16 is variably subnetted, 3 subnets, 2 masks
S       172.16.0.0/22 [1/0] via 192.168.1.2
S       172.16.1.0/24 [1/0] via 192.168.1.2
S       172.16.2.0/24 is directly connected, Serial0/1
C    192.168.1.0/24 is directly connected, Serial0/1
C    192.168.2.0/24 is directly connected, FastEthernet0/0
```

Configuring a summary route on R3 did not remove the static routes configured earlier because these routes are more specific routes. They both use **/24** mask, whereas the new summary will be using a **/22** mask. To reduce the size of the routing table, we can now remove the more specific **/24** routes.

Step 3: Remove static routes on R3.

Remove the two static routes that are currently configured on R3 by using the **no** form of the command.

```
R3(config)#no ip route 172.16.1.0 255.255.255.0 192.168.1.2
R3(config)#no ip route 172.16.2.0 255.255.255.0 Serial0/1
```

Step 4: Verify that the routes are no longer in the routing table.

```
R3#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/22 is subnetted, 1 subnets
S       172.16.0.0 [1/0] via 192.168.1.2
C    192.168.1.0/24 is directly connected, Serial0/1
C    192.168.2.0/24 is directly connected, FastEthernet0/0
```

R3 now only has one route to any host belonging to networks 172.16.0.0/24, 172.16.1.0/24, 172.16.2.0/24, and 172.16.3.0/24. Traffic destined for these networks will be sent to R2 at 192.168.1.2.

Step 5: Use `ping` to check connectivity between the host PC3 and PC1.

From the host PC3, is it possible to ping the host PC1? This ping should be successful this time because there is a route to the 172.16.3.0 network on the R3 router, and the R1 router can return the packet using the default route.

Task 12: Completing the assignment

Using WebCT answer the questions asked in this assignment.

Task 13: Clean Up

Erase the configurations and turn-off the routers. I suggest copying your running-configs to a flash drive for your own future reference.

